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RESEARCH MEMORANDUM

STATIC STABILITY AND CONTROL OF CANARD CONFIGURATIONS AT MACH NUMBERS FROM 0.70 TO 2.22 - LONGITUDINAL CHARACTERISTICS OF A TRIANGULAR WING AND UNSWEPT CANARD

By Victor L. Peterson and Gene P. Menees

Ames Aeronautical Laboratory
Moffett Field, Calif.

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STATIC STABILITY AND CONTROL OF CANARD CONFIGURATIONS AT MACH NUMBERS FROM 0.70 TO 2.22 - LONGITUDINAL CHARACTERISTICS OF A TRIANGULAR WING AND UNSWEPT CANARD

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SUMMARY

The results of an investigation of the static longitudinal stability and control characteristics of a canard airplane configuration are presented without analysis for the Mach number range from 0.70 to 2.22. The configuration consisted of an aspect ratio 2.0 triangular wing, an aspect ratio 3.0 unswept canard, a low aspect ratio vertical tail, and a Sears-Haack body. The hinge line of the canard was in the extended chord plane of the wing, 1.15 wing mean aerodynamic chords ahead of the reference center of moments. The ratio of the area of the exposed canard panels to the total area of the wing was 8.1 percent. Data are presented for various combinations of the canard, wing, and vertical tail for an angle-of-attack range from -6° to $+18^{\circ}$. The canard deflection angles ranged from 0° to $+20^{\circ}$.

INTRODUCTION

The possible gains to be realized at supersonic speeds in the form of reduced trim drag and increased maneuverability by the use of canards rather than conventional tail-aft controls have resulted in increased interest in these arrangements. Therefore, an extensive research program aimed at determining the static longitudinal and directional characteristics of a number of canard configurations has been undertaken by the NACA.

A part of the program conducted at the Ames Aeronautical Laboratory was directed at determining the effects of canard plan form. This report is one of a series pertaining to the program and presents without analysis the longitudinal characteristics of one complete configuration and

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its component parts. This configuration, which differed from that of reference 1 only in the canard plan form, consisted of an aspect ratio 2.0 triangular wing, an aspect ratio 3.0 unswept canard, a low aspect ratio vertical tail, and a Sears-Haack body.

The longitudinal stability and control characteristics for a similar configuration with an aspect ratio 2.0 triangular canard are presented in reference 1. Results from another phase of the investigation are reported in reference 2.

NOTATION

a.c.	aerodynamic center determined at $C_L = 0$, percent $\bar{c}$
$\bar{c}$	mean aerodynamic chord of wing, ft
c_c	canard root chord, ft
C_D	drag coefficient, $\frac{\text{drag}}{qS}$
C_{D_o}	drag coefficient at zero lift
C_L	lift coefficient, $\frac{\text{lift}}{qS}$
C_{L_α}	lift-curve slope taken through zero angle of attack, per deg
C_m	pitching-moment coefficient, $\frac{\text{pitching moment}}{qS\bar{c}}$, referred to the projection of the $0.15\bar{c}$ point on the fuselage reference line (Center of moments for data in ref. 1 was obtained by projection of the $0.21\bar{c}$ point on fuselage reference line.)
C_{h_c}	canard hinge-moment coefficient, $\frac{\text{canard hinge moment}}{qS_c(c_c/2)}$, referred to the projection of the $0.50c_c$ point on the fuselage reference line
C_{Z_c}	force coefficient normal to canard, $\frac{\text{canard normal force}}{qS}$
$\left(\frac{L}{D}\right)_{max}$	maximum lift-drag ratio
M	free-stream Mach number
q	free-stream dynamic pressure, lb/sq ft

S	wing area formed by extending the leading and trailing edges to the plane of symmetry, sq ft
S_c	canard exposed area, sq ft
α	angle of attack of wing root chord, deg
δ	angle of deflection of the canard with respect to the extended wing chord plane, positive when trailing edge is down, deg

Configurations are denoted by the following letters used in combination:

B	body
C	canard
V	vertical tail
W	wing

APPARATUS AND MODEL

Test Facility

The experimental data were obtained in the Ames 6- by 6-foot supersonic wind tunnel which is a closed-circuit variable-pressure type with a Mach number range continuous from 0.70 to 2.22. A recent modification involved perforating the test-section floor and ceiling and adding a boundary-layer removal system to enable uniform flow to be maintained at transonic and low supersonic speeds. At the same time injector flaps were installed downstream of the test section to extend the upper Mach number limit by reducing the required compression ratio across the nozzle and by better matching the weight flow characteristics of the nozzle with those of the compressor.

Analysis of the results of an extensive survey of the modified wind-tunnel characteristics, although incomplete, is sufficiently complete to establish the validity of the results of the present investigation.

Description of Model and Balances

The sting-mounted model consisted of an aspect ratio 2.0 triangular wing, an aspect ratio 3.0 unswept canard, and a low aspect ratio vertical tail, all mounted on a fineness ratio 12.5 Sears-Haack body. A dimensional sketch of the model is shown in figure 1(a). The wing and vertical tail had NACA 0003-63 sections streamwise and the constant thickness canard, detailed in figure 1(b), had beveled leading and trailing edges. The canard, which was pivoted about the 0.50 canard root chord, was mounted in the extended wing chord plane 1.15 wing mean aerodynamic chords ahead of the reference center of moments ($0.15\bar{c}$). The ratio of the area of the exposed canard panels to the total area of the wing was 8.1 percent and the ratio of the total areas was 11.5 percent. The wing, canard, and vertical tail were of solid steel construction to minimize aeroelastic effects. The surfaces were polished to give a smooth surface and further treated to prevent corrosion.

The fuselage was cut off as shown in figure 1(a) to accommodate the sting and the six-component strain-gage balance which measured forces and moments on the entire configuration. Canard normal forces and hinge moments were obtained from a two-component strain-gage balance mounted in the nose of the fuselage. The canard, wing, and vertical tail were removable, enabling data to be taken which would permit an evaluation of the contribution of each of the component parts of the model and the interference between parts.

TEST AND PROCEDURES

Range of Test Variables

Mach numbers of 0.70, 0.90, 1.00, 1.10, 1.30, 1.70, and 2.22 were covered in the investigation. The test Reynolds number based on the wing mean aerodynamic chord was 1.84 million at Mach numbers of 1.00 and 1.10, and 3.68 million at all other Mach numbers. The smaller Reynolds number at transonic speeds was necessary because of model structural limitations.

At the relatively low Reynolds numbers at which most wind tunnels operate, extensive regions of laminar flow can exist on models at zero lift. At lifting conditions the transition points on the model surfaces usually move forward, thus causing a change in friction drag with changing lift coefficient which is difficult to evaluate and, moreover, not necessarily representative of full scale. In order to induce transition at fixed locations on the component parts, a 0.010-inch-diameter wire was placed on the wing and 0.005-inch-diameter wires were affixed to the canard and vertical tail in the locations shown in figure 1(a). When the model was tested with the canard off, a 0.010-inch-diameter wire was located on the body 4 inches from the nose. The wire sizes were selected on the basis of the results of reference 3. Although there is no conclusive evidence as to the magnitude of the form drag increment contributed by the transition wires, previous studies have indicated this increment to be not more than 0.0010. All of the data presented herein are for transition-fixed conditions.

Reduction of Data

The data presented herein have been reduced to standard NACA coefficient form. The moment center for data presented herein was chosen so that the minimum static margin in the range of trim lift coefficients between 0 and 0.5 throughout the Mach number range investigated was $0.03\bar{c}$; the resulting moment center was at the 0.15 point of the wing mean aerodynamic chord.[1] The canard hinge moments were computed about a hinge line located at the 0.50 point of the canard root chord. Factors which affect the accuracy of the results are discussed in the following paragraphs.

Stream variations.- Surveys of the stream characteristics of the Ames 6- by 6-foot supersonic wind tunnel showed that in the region of the test section, essentially no stream curvature existed in the pitch plane of the model and that axial static-pressure variations were usually less than ±1 percent of the dynamic pressure. This static-pressure variation resulted in negligible longitudinal-buoyancy corrections to the drag of this model. Therefore, no corrections for stream curvature or static-pressure variation were made in the present investigation.

From a test of the model in the normal and inverted attitudes, a stream angle, which was less than $\pm 0.30^\circ$ throughout the Mach number range, was found to exist in the pitch plane. The data presented herein have been corrected for these stream angles which correlated closely with those obtained from a cone survey.

Support interference.- The effects of model support interference on the aerodynamic characteristics were considered to consist primarily of a change in the pressure at the base of the model. However, the drag data presented herein contain no base drag component since the base pressure was measured and the drag was adjusted to correspond to that in which the base pressure is equal to the free-stream static pressure; therefore, no corrections were made to take into account support interference.

Tunnel-wall interference.- The effectiveness of the perforations in the wind-tunnel test section in preventing choking and absorbing reflected disturbances at transonic and low supersonic speeds has been established experimentally. Unpublished data from the wind-tunnel calibration indicate that reliable data can be obtained throughout the Mach number range if certain restrictions are imposed on the model size and attitude. The configurations and methods of testing used in the present investigation

[1]A similar stability criterion was used to select the center of moments for the data presented in reference 1; the resulting center of moments was, however, at the 0.21 point of the wing mean aerodynamic chord.

conform to these restrictions so that data at transonic and low supersonic speeds are reasonably free of interference effects. Thus, no corrections for wall interference have been made.

RESULTS

The results are presented in this report without analysis in order to expedite publication. All of the experimental data are tabulated in tables I and II. Selected portions of the data are presented in figures 2 through 4. Lift, drag, and pitching-moment characteristics are presented in figure 2 for several test Mach numbers for the canard on and off. Figure 3 shows the variations of canard normal forces and hinge moments as a function of angle of attack at constant canard deflection angles. Summarized in figure 4 are the lift-curve slopes, maximum lift-drag ratios, minimum drag coefficients, and aerodynamic centers as a function of Mach number for the canard on at zero deflection and for the canard off.

Ames Aeronautical Laboratory
National Advisory Committee for Aeronautics
Moffett Field, Calif., Nov. 26, 1957

REFERENCES

1. Boyd, John W., and Peterson, Victor L.: Static Stability and Control of Canard Configurations at Mach Numbers From 0.70 to 2.22 - Longitudinal Characteristics of a Triangular Wing and Canard. NACA RM A57J15, 1957.

2. Boyd, John W., and Peterson, Victor L.: Static Stability and Control of Canard Configurations at Mach Numbers From 0.70 to 2.22 - Triangular Wing and Canard on an Extended Body. NACA RM A57K14, 1958.

3. Winter, K. G., Scott-Wilson, J. B., and Davies, F. V.: Methods of Determination and of Fixing Boundary-Layer Transition on Wind Tunnel Models at Supersonic Speeds. R.A.E. TN Aero 2341, British, Sept. 1954.

TABLE I.- AERODYNAMIC CHARACTERISTICS WITH THE WING ON

(a) BVW

M	α, deg	C_L	C_D	C_m
0.70	-6.4	-0.311	0.0404	0.0792
	-4.2	-.196	.0214	.0507
	-2.2	-.101	.0130	.0268
	-.7	-.039	.0107	.0131
	-.2	-.018	.0104	.0080
	.4	.004	.0103	.0041
	1.9	.066	.0113	-.0114
	3.9	.164	.0183	-.0356
	5.8	.260	.0317	-.0591
	7.8	.368	.0538	-.0858
	9.8	.478	.0844	-.1117
	11.7	.588	.1210	-.1379
	13.8	.702	.1681	-.1664
	15.8	.808	.2225	-.1897
	17.8	.919	.2862	-.2146
0.90	-6.0	-.324	.0411	.0725
	-3.9	-.202	.0221	.0578
	-1.9	-.098	.0125	.0312
	-.6	-.037	.0110	.0138
	0	-.012	.0107	.0078
	.6	.010	.0107	.0026
	2.0	.077	.0120	-.0162
	4.0	.180	.0200	-.0448
	6.0	.291	.0370	-.0762
	7.9	.410	.0620	-.1105
	10.0	.540	.0992	-.1518
	12.0	.661	.1434	-.1890
	14.0	.789	.1983	-.2356
	16.0	.913	.2627	-.2814

M	α, deg	C_L	C_D	C_m
1.00	-5.8	-0.347	0.0483	0.1233
	-3.8	-.222	.0295	.0807
	-1.8	-.109	.0174	.0409
	-.3	-.031	.0149	.0156
	.2	-.007	.0154	.0060
	.7	.024	.0155	-.0036
	2.2	.104	.0178	-.0299
	4.2	.222	.0288	-.0710
	6.3	.345	.0490	-.1131
	8.2	.459	.0768	-.1503
	10.3	.580	.1153	-.1891
	12.2	.686	.1585	-.2228
	14.2	.792	.2089	-.2592
	16.3	.897	.2704	-.2966
	18.2	.990	.3326	-.3296
1.10	-6.0	-.334	.0484	.1232
	-4.0	-.215	.0294	.0824
	-2.0	-.106	.0194	.0427
	-.4	-.027	.0162	.0162
	.1	-.004	.0160	.0081
	.6	.024	.0163	-.0026
	2.1	.102	.0186	-.0291
	4.1	.214	.0279	-.0712
	6.1	.330	.0469	-.1133
	8.1	.446	.0723	-.1532
	10.1	.544	.1043	-.1821
	12.1	.636	.1449	-.2170
	14.1	.739	.1934	-.2573
	16.1	.838	.2506	-.2933
	18.1	.924	.3105	-.3227

M	α, deg	C_L	C_D	C_m
1.30	-6.0	-0.291	0.0418	0.1070
	-4.0	-.189	.0254	.0691
	-2.0	-.093	.0169	.0384
	-.5	-.026	.0145	.0102
	0	-.005	.0139	.0038
	.6	.019	.0145	-.0041
	2.1	.087	.0167	-.0286
	4.0	.181	.0246	-.0617
	6.0	.278	.0399	-.0951
	8.0	.374	.0620	-.1286
	10.0	.470	.0910	-.1625
	12.0	.562	.1264	-.1952
	14.1	.650	.1677	-.2273
	16.1	.735	.2146	-.2565
	18.1	.809	.2660	-.2808
1.70	-6.3	-.239	.0376	.0847
	-4.1	-.160	.0238	.0568
	-2.2	-.084	.0163	.0309
	-.7	-.031	.0140	.0122
	-.1	-.010	.0136	.0050
	.4	.012	.0137	-.0019
	1.8	.065	.0152	-.0203
	3.8	.143	.0215	-.0472
	5.8	.216	.0327	-.0720
	7.8	.290	.0493	-.0973
	9.8	.362	.0721	-.1215
	11.8	.430	.0988	-.1455
	13.9	.499	.1299	-.1684
	15.9	.565	.1666	-.1890
	17.9	.627	.2063	-.2068

M	α, deg	C_L	C_D	C_m
2.22	-5.9	-0.185	0.0308	0.0624
	-3.6	-.114	.0191	.0383
	-1.7	-.057	.0139	.0200
	-.3	-.013	.0124	.0060
	.2	.003	.0123	.0009
	.8	.022	.0126	-.0046
	2.2	.068	.0145	-.0204
	4.2	.129	.0207	-.0407
	6.2	.187	.0309	-.0590
	8.3	.244	.0453	-.0774
	10.2	.300	.0629	-.0945
	12.3	.357	.0862	-.1116
	14.2	.409	.1115	-.1260
	16.2	.465	.1426	-.1404
	18.3	.519	.1777	-.1559

TABLE I.- AERODYNAMIC CHARACTERISTICS WITH THE WING ON - Continued

(b) BVWC; δ = 0.3°

M	α, deg	C_L	C_D	C_m	C_{Z_c}	C_{h_c}
0.70	-6.3	-0.329	0.0436	0.0296	-0.0412	-0.1329
	-4.2	-.213	.0246	.0207	-.0271	-.1033
	-2.1	-.110	.0155	.0130	-.0139	-.0520
	-.8	-.049	.0121	.0096	-.0054	-.0203
	.3	-.002	.0116	.0066	.0008	-.0021
	1.7	.060	.0125	.0037	.0096	.0272
	3.9	.161	.0185	-.0028	.0225	.0836
	5.8	.264	.0332	-.0102	.0352	.1236
	7.8	.373	.0557	-.0184	.0486	.1314
	9.8	.494	.0882	-.0309	.0596	.1184
	11.9	.610	.1301	-.0545	.0615	.0796
	13.8	.717	.1761	-.0799	.0607	.0591
	15.8	.824	.2313	-.1009	.0627	.0593
	17.9	.950	.3030	-.1216	.0676	.0612
0.90	-6.1	-.348	0.0463	0.0364	-.0483	-.1444
	-4.0	-.227	.0258	.0257	-.0308	-.1218
	-1.9	-.109	.0150	.0160	-.0142	-.0524
	-.6	-.046	.0120	.0103	-.0054	-.0207
	.6	.007	.0121	.0057	.0016	.0042
	2.0	.075	.0136	.0001	.0108	.0369
	4.0	.184	.0222	-.0096	.0258	.1006
	6.0	.299	.0386	-.0183	.0426	.1421
	8.0	.428	.0667	-.0345	.0577	.1509
	10.0	.561	.1044	-.0529	.0719	.1584
	12.1	.679	.1499	-.0920	.0688	.0941
	14.0	.806	.2055	-.1325	.0729	.0677
	16.0	.926	.2698	-.1699	.0749	.0522
	18.1	1.045	.3447	-.2083	.0782	.0474
1.00	-5.8	-.352	0.0524	0.0626	-.0453	-.0907
	-3.7	-.227	.0326	.0438	-.0292	-.0773
	-1.8	-.115	.0218	.0246	-.0148	-.0427
	-.4	-.034	.0191	.0104	-.0043	-.0117
	.8	.023	.0188	.0009	.0025	-.0006
	2.2	.110	.0229	-.0152	.0134	.0245
	4.3	.220	.0332	-.0340	.0277	.0645
	6.3	.353	.0536	-.0551	.0443	.0828
	8.1	.466	.0794	-.0734	.0574	.0870
	10.3	.587	.1185	-.0944	.0704	.0889
	12.3	.704	.1644	-.1126	.0831	.0842
	14.2	.808	.2148	-.1308	.0941	.0800
	16.2	.906	.2734	-.1472	.1036	.0786
	18.3	1.009	.3429	-.1773	.1072	.0612
1.10	-6.1	-.342	.0547	.0662	-.0444	-.0788
	-4.0	-.231	.0351	.0467	-.0297	-.0675
	-2.1	-.120	.0241	.0299	-.0145	-.0398
	-.4	-.040	.0211	.0136	-.0045	-.0101
	.6	.013	.0197	.0056	.0020	-.0013
	2.0	.077	.0227	-.0048	.0111	.0226
	3.8	.188	.0293	-.0243	.0257	.0547
	6.1	.317	.0482	-.0457	.0412	.0689
	8.0	.430	.0734	-.0661	.0537	.0756
	10.0	.559	.1098	-.0906	.0654	.0780
	12.0	.663	.1513	-.1047	.0755	.0756
	14.1	.760	.1989	-.1142	.0867	.0742
	16.2	.842	.2529	-.1252	.0961	.0733
	18.1	.923	.3115	-.1444	.1034	.0698

M	α, deg	C_L	C_D	C_m	C_{Z_c}	C_{h_c}
1.30	-5.8	-0.283	0.0441	0.0450	-0.0382	-0.0486
	-4.0	-.194	.0291	.0313	-.0271	-.0377
	-1.9	-.094	.0200	.0146	-.0143	-.0245
	-.5	-.035	.0175	.0055	-.0058	-.0138
	.5	.015	.0171	-.0014	.0009	-.0015
	2.1	.078	.0195	-.0111	.0097	.0136
	4.1	.176	.0270	-.0267	.0225	.0304
	5.9	.269	.0422	-.0421	.0342	.0404
	8.0	.369	.0647	-.0581	.0466	.0501
	10.0	.474	.0957	-.0735	.0581	.0566
	12.0	.568	.1311	-.0886	.0679	.0624
	14.0	.666	.1742	-.1049	.0780	.0635
	16.2	.761	.2275	-.1246	.0864	.0614
	18.0	.842	.2798	-.1401	.0944	.0536
1.70	-6.3	-.241	0.0411	0.0375	-.0296	-.0170
	-4.2	-.170	.0277	.0279	-.0208	-.0122
	-2.2	-.092	.0193	.0161	-.0111	-.0065
	-.8	-.038	.0163	.0075	-.0044	-.0038
	.3	0	.0158	.0019	.0003	-.0021
	1.8	.056	.0173	-.0064	.0074	.0048
	3.8	.135	.0238	-.0182	.0171	.0098
	5.9	.215	.0362	-.0296	.0268	.0163
	7.9	.295	.0539	-.0399	.0364	.0235
	9.8	.366	.0756	-.0501	.0449	.0272
	11.8	.445	.1051	-.0608	.0540	.0312
	13.8	.515	.1377	-.0710	.0620	.0342
	15.9	.589	.1776	-.0814	.0701	.0354
	17.9	.656	.2213	-.0920	.0771	.0333
2.22	-5.7	-.185	.0323	.0269	-.0204	-.0063
	-3.6	-.122	.0217	.0182	-.0135	-.0059
	-1.8	-.060	.0158	.0094	-.0072	-.0038
	-.3	-.017	.0141	.0025	-.0025	-.0023
	.8	.020	.0142	-.0033	.0011	-.0017
	2.3	.065	.0161	-.0107	.0058	.0013
	4.3	.129	.0224	-.0196	.0128	.0031
	6.2	.187	.0330	-.0269	.0194	.0046
	8.3	.249	.0483	-.0340	.0263	.0075
	10.2	.312	.0677	-.0408	.0339	.0080
	12.3	.370	.0919	-.0462	.0411	.0107
	14.3	.427	.1197	-.0516	.0482	.0132
	16.3	.485	.1526	-.0565	.0553	.0172
	18.4	.539	.1889	-.0617	.0622	.0207

TABLE I.- AERODYNAMIC CHARACTERISTICS WITH THE WING ON - Continued

(c) BVWC; $\delta = 4.7^{\circ}$

M	α, deg	C_L	C_D	C_m	C_{Z_c}	C_{h_c}
0.70	-6.2	-0.321	0.0407	0.0655	-0.0142	-0.0436
	-2.2	-.108	.0147	.0446	.0097	.0423
	-.2	-.020	.0123	.0390	.0225	.0930
	5.8	.265	.0391	.0221	.0348	.1247
	1.7	.059	.0147	.0382	.0584	.1218
	9.8	.490	.0946	-.0292	.0596	.0717
	13.8	.715	.1819	-.0746	.0634	.0687
	17.9	.942	.3067	-.1112	.0727	.0706
0.90	-6.0	-.335	.0426	.0814	-.0140	-.0342
	-1.9	-.106	.0150	.0499	.0122	.0601
	.1	-.013	.0129	.0442	.0269	.1194
	2.0	.075	.0161	.0452	.0435	.1519
	6.0	.297	.0457	.0251	.0715	.1660
	10.1	.547	.1100	-.0481	.0713	.0717
	14.0	.801	.2116	-.1226	.0761	.0539
	18.0	1.011	.3391	-.1770	.0824	.0522
1.00	-5.9	-.352	.0504	.1097	-.0140	-.0203
	-1.8	-.106	.0241	.0613	.0140	.0455
	.2	.001	.0188	.0421	.0299	.0775
	2.2	.093	.0241	.0322	.0443	.0916
	6.3	.340	.0588	-.0110	.0708	.1035
	10.2	.576	.1247	-.0528	.0945	.0909
	14.2	.799	.2221	-.1053	.1067	.0696
	18.3	.999	.3505	-.1583	.1141	.0354
1.10	-6.0	-.345	.0523	.1094	-.0138	-.0272
	-2.0	-.115	.0239	.0632	.0132	.0432
	.1	-.020	.0203	.0479	.0286	.0662
	1.9	.067	.0247	.0393	.0411	.0731
	6.2	.302	.0550	0	.0659	.0889
	10.1	.552	.1184	-.0526	.0877	.0826
	14.1	.777	.2142	-.1058	.0990	.0614
	18.1	.920	.3192	-.1324	.1074	.0339
1.30	-6.0	-0.291	0.0435	0.0866	-0.0124	-0.0107
	-1.9	-.101	.0206	.0546	.0121	.0251
	.1	-.013	.0188	.0412	.0249	.0381
	1.9	.066	.0221	.0311	.0358	.0486
	6.0	.265	.0476	-.0024	.0588	.0616
	10.1	.472	.1034	-.0407	.0785	.0681
	14.0	.665	.1841	-.0769	.0954	.0587
	18.1	.832	.2871	-.1056	.1075	.0528
1.70	-6.2	-.241	.0385	.0712	-.0087	.0019
	-2.2	-.088	.0193	.0479	.0100	.0132
	-.2	-.017	.0175	.0365	.0196	.0187
	1.8	.056	.0202	.0267	.0290	.0241
	5.8	.217	.0412	.0026	.0474	.0350
	9.8	.374	.0842	-.0220	.0637	.0432
	13.8	.523	.1483	-.0454	.0790	.0396
	17.9	.658	.2317	-.0689	.0927	.0325
2.22	-5.8	-.177	.0308	.0519	-.0044	.0031
	-1.7	-.053	.0160	.0328	.0087	.0078
	.4	.012	.0154	.0227	.0157	.0086
	2.2	.066	.0183	.0147	.0216	.0117
	6.3	.196	.0378	-.0014	.0366	.0136
	10.3	.320	.0751	-.0149	.0515	.0182
	14.3	.437	.1294	-.0280	.0652	.0272
	18.3	.539	.1971	-.0371	.0772	.0306

TABLE I.- AERODYNAMIC CHARACTERISTICS WITH THE WING ON - Continued

(d) BVWC; $\delta = 10.1^\circ$

M	α, deg	C_L	C_D	C_m	C_{Z_c}	C_{h_c}
0.70	-6.2	-0.310	0.0410	0.0947	0.0090	0.0432
	-2.2	-.097	.0169	.0761	.0350	.1178
	-.3	-.013	.0174	.0695	.0460	.1222
	1.7	.066	.0206	.0632	---	---
	6.0	.275	.0467	.0184	.0584	.0748
	9.8	.493	.0998	-.0271	.0623	.0650
	13.8	.720	.1899	-.0681	.0691	.0689
	17.9	.958	.3198	-.1081	.0789	.0683
0.90	-6.1	-.342	.0461	.1186	.0101	.0633
	-2.0	-.102	.0196	.0912	.0430	.1473
	.2	0	.0194	.0827	.0590	.1542
	2.1	.083	.0238	.0733	.0709	.1547
	6.0	.305	.0533	.0170	.0707	.0719
	10.1	.552	.1181	-.0441	.0775	.0541
	14.2	.805	.2237	-.1141	.0831	.0471
	18.1	1.039	.3585	-.1883	.0898	.0438
1.00	-5.8	-.344	.0512	.1464	.0146	.0451
	-1.9	-.106	.0278	.1021	.0446	.0849
	.2	0	.0230	.0805	.0581	.0937
	2.3	.102	.0309	.0584	.0709	.0956
	6.3	.339	.0647	.0214	.0944	.0853
	10.2	.580	.1337	-.0430	.1027	.0591
	14.2	.799	.2328	-.0988	.1130	.0323
	18.2	1.024	.3686	-.1591	.1231	.0170
1.10	-6.1	-.343	.0542	.1437	.0127	.0390
	-2.0	-.117	.0285	.1025	.0418	.0727
	-.1	-.039	.0266	.0916	.0528	.0773
	2.0	.065	.0303	.0691	.0647	.0830
	6.0	.295	.0621	.0339	.0865	.0767
	10.0	.537	.1263	-.0367	.0947	.0576
	14.1	.785	.2259	-.1088	.1044	.0323
	18.0	.938	.3343	-.1315	.1133	.0180
1.30	-6.0	-0.289	0.0457	0.1243	0.0125	0.0342
	-1.8	-.091	.0249	.0886	.0380	.0492
	.1	-.018	.0241	.0751	.0481	.0536
	2.0	.064	.0274	.0622	.0588	.0589
	6.1	.270	.0568	.0243	.0777	.0652
	10.0	.473	.1129	-.0162	.0947	.0560
	14.1	.671	.1966	-.0616	.1072	.0453
	18.2	.860	.3092	-.1276	.1109	.0180
1.70	-6.2	-.235	.0404	.1021	.0114	.0187
	-2.2	-.086	.0237	.0784	.0298	.0304
	-.2	-.015	.0226	.0659	.0391	.0327
	1.8	.057	.0259	.0553	.0477	.0358
	5.9	.222	.0493	.0278	.0641	.0467
	9.9	.377	.0936	.0008	.0787	.0427
	13.8	.527	.1589	-.0250	.0930	.0325
	18.0	.665	.2460	-.0531	.1042	.0218
2.22	-5.8	-.168	.0311	.0740	.0104	.0128
	-1.5	-.039	.0191	.0540	.0243	.0140
	.4	.015	.0191	.0458	.0310	.0126
	2.3	.073	.0235	.0380	.0375	.0159
	6.3	.201	.0447	.0219	.0522	.0243
	10.1	.319	.0813	.0082	.0657	.0319
	14.3	.436	.1373	-.0087	.0776	.0346
	18.3	.544	.2078	-.0246	.0890	.0298

TABLE I.- AERODYNAMIC CHARACTERISTICS WITH THE WING ON - Continued

(e) BVWC; $\delta = 20.0^{\circ}$

M	α, deg	C_L	C_D	C_m	C_{Z_c}	C_{h_c}
0.70	-6.3	-0.296	0.0562	0.1469	0.0495	0.1234
	-2.2	-.086	.0311	.0988	.0539	.0767
	-.2	-.005	.0303	.0792	.0554	.0765
	1.8	.070	.0324	.0637	.0577	.0752
	5.8	.260	.0564	.0278	.0647	.0742
	9.8	.479	.1109	-.0124	.0703	.0756
	13.8	.704	.2014	-.0509	.0786	.0677
	17.8	.935	.3290	-.0905	.0870	.0591
0.90	-5.9	-.303	.0577	.1634	.0528	.1132
	-2.0	-.087	.0349	.1141	.0634	.0736
	.1	0	.0339	.0911	.0657	.0648
	2.0	.084	.0377	.0761	.0701	.0643
	6.1	.297	.0674	.0282	.0762	.0599
	10.0	.530	.1297	-.0247	.0817	.0503
	14.1	.789	.2347	-.0954	---	---
	18.1	1.019	.3706	-.1666	.0951	.0363
1.00	-5.8	-.335	.0725	.2182	.0629	.0964
	-1.7	-.089	.0472	.1534	.0773	.0815
	.3	.007	.0462	.1171	.0829	.0706
	2.2	.103	.0499	.0884	.0849	.0534
	6.3	.327	.0825	.0358	.0949	.0339
	10.2	.564	.1506	-.0226	.1071	.0243
	14.3	.792	.2497	-.0892	.1103	.0166
	18.2	.990	.3753	-.1502	.1134	.0090
1.10	-6.0	-.334	.0738	.2125	.0608	.0863
	-2.0	-.124	.0503	.1659	.0754	.0746
	.1	-.023	.0477	.1322	.0776	.0641
	2.0	.069	.0518	.1028	.0803	.0524
	6.1	.311	.0853	.0325	.0911	.0325
	10.0	.542	.1489	-.0262	.1015	.0212
	14.1	.779	.2438	-.1064	.1030	.0128
	18.1	.950	.3565	-.1320	.1072	.0080
1.30	-6.0	-0.280	0.0626	0.1864	0.0539	0.0654
	-1.9	-.095	.0444	.1399	.0678	.0702
	.1	-.014	.0447	.1191	.0745	.0635
	2.0	.058	.0487	.0998	.0806	.0572
	6.1	.261	.0756	.0507	.0894	.0396
	10.1	.472	.1338	.0001	.0979	.0193
	14.2	.675	.2190	-.0633	.1054	.0115
	18.1	.853	.3274	-.1185	.1116	.0008
1.70	-6.2	-.218	.0542	.1534	.0444	.0536
	-2.1	-.078	.0405	.1240	.0580	.0583
	-.1	-.013	.0409	.1082	.0639	.0583
	1.8	.053	.0441	.0942	.0698	.0530
	5.8	.221	.0691	.0630	.0809	.0421
	9.8	.379	.1152	.0304	.0904	.0224
	13.9	.524	.1802	-.0102	.0964	.0109
	17.9	.649	.2619	-.0437	.1045	-.0044
2.22	-5.7	-.145	.0426	.1147	.0389	.0302
	-1.7	-.031	.0344	.0960	.0507	.0354
	.3	.023	.0360	.0851	.0559	.0402
	2.2	.083	.0405	.0751	.0613	.0438
	6.3	.211	.0640	.0546	.0712	.0486
	10.3	.329	.1040	.0351	.0797	.0404
	14.3	.438	.1590	.0153	.0880	.0268
	18.3	.538	.2279	-.0055	.0946	.0107

TABLE I.- AERODYNAMIC CHARACTERISTICS WITH THE WING ON - Concluded

(f) BW

M	α, deg	C_L	C_D	C_m
0.70	-6.3	-0.307	0.0378	0.0783
	-4.3	-.200	.0206	.0513
	-2.3	-.099	.0117	.0257
	-.8	-.040	.0095	.0134
	-.3	-.018	.0087	.0084
	.2	.004	.0091	.0044
	1.7	.065	.0101	-.0100
	3.7	.162	.0165	-.0343
	5.7	.264	.0305	-.0589
	7.8	.376	.0534	-.0870
	9.8	.489	.0845	-.1131
	11.7	.602	.1229	-.1403
	13.7	.715	.1700	-.1676
	15.7	.829	.2259	-.1933
	17.7	.934	.2881	-.2160
0.90	-6.0	-.326	.0399	.0937
	-4.0	-.206	.0211	.0587
	-2.0	-.097	.0119	.0232
	-.5	-.031	.0096	.0127
	0	-.010	.0094	.0071
	.2	.025	.0165	0
	2.0	.084	.0108	-.0169
	4.0	.190	.0202	-.0467
	6.0	.305	.0371	-.0794
	8.0	.436	.0657	-.1208
	10.0	.556	.1008	-.1582
	12.0	.683	.1476	-.2014
	14.0	.804	.2018	-.2437
	16.0	.936	.2699	-.2917
	18.0	.933	.3039	-.2621

M	α, deg	C_L	C_D	C_m
1.00	-5.9	-0.338	0.0483	0.1187
	-3.8	-.212	.0253	.0746
	-1.8	-.094	.0191	.0334
	-.3	-.021	.0145	.0089
	.2	.010	.0172	-.0002
	.7	.031	.0147	-.0080
	2.1	.110	.0179	-.0348
	4.1	.233	.0346	-.0763
	6.2	.348	.0489	-.1184
	8.2	.471	.0799	-.1595
	10.2	.584	.1150	-.1982
	12.1	.694	.1589	-.2351
	14.2	.799	.2107	-.2736
	16.2	.906	.2707	-.3110
	18.2	.997	.3351	-.3440
1.10	-6.0	-.322	.0459	.1161
	-4.0	-.203	.0277	.0771
	-2.0	-.088	.0177	.0347
	-.5	-.018	.0153	.0099
	0	.007	.0156	.0022
	.5	.028	.0157	-.0048
	2.0	.106	.0179	-.0310
	4.0	.216	.0282	-.0711
	6.0	.329	.0453	-.1131
	8.0	.452	.0725	-.1572
	10.0	.555	.1052	-.1865
	11.9	.638	.1427	-.2114
	14.0	.751	.1956	-.2596
	16.0	.843	.2499	-.2935
	18.0	.933	.3114	-.3256

M	α, deg	C_L	C_D	C_m
1.30	-6.1	-0.286	0.0400	0.1024
	-4.0	-.185	.0236	.0660
	-2.0	-.086	.0150	.0312
	-.5	-.024	.0131	.0086
	-.1	0	.0130	.0017
	.5	.018	.0131	-.0045
	2.0	.089	.0154	-.0294
	3.9	.183	.0229	-.0628
	6.0	.282	.0389	-.0981
	8.0	.379	.0612	-.1308
	10.0	.475	.0906	-.1643
	12.0	.564	.1253	-.1958
	13.9	.653	.1659	-.2279
	16.0	.738	.2131	-.2567
	18.0	.820	.2662	-.2852
1.70	-6.3	-.236	.0357	.0400
	-4.3	-.162	.0229	.0261
	-2.2	-.078	.0147	.0173
	-.8	-.027	.0126	.0145
	-.2	-.007	.0123	.0136
	.3	.012	.0125	.0138
	1.8	.068	.0141	.0147
	3.8	.144	.0205	.0198
	5.8	.219	.0319	.0304
	7.8	.294	.0494	.0464
	9.8	.365	.0711	.0673
	11.8	.432	.0974	.0929
	13.7	.498	.1277	.1217
	15.8	.567	.1646	.1574
	17.8	.632	.2054	.1971

M	α, deg	C_L	C_D	C_m
2.22	-5.8	-0.173	0.0274	0.0558
	-3.8	-.114	.0177	.0368
	-1.7	-.050	.0122	.0164
	-.2	-.006	.0109	.0027
	.3	.009	.0109	-.0017
	.7	.024	.0111	-.0061
	2.2	.070	.0131	-.0215
	4.2	.130	.0195	-.0412
	6.2	.187	.0298	-.0598
	8.3	.244	.0443	-.0778
	10.2	.297	.0615	-.0934
	12.2	.351	.0834	-.1097
	14.2	.406	.1091	-.1243
	16.2	.463	.1399	-.1392
	18.2	.514	.1747	-.1541

TABLE II.- AERODYNAMIC CHARACTERISTICS WITH THE WING OFF

(a) BV

M	α, deg	C_L	C_D	C_m	M	α, deg	C_L	C_D	C_m	M	α, deg	C_L	C_D	C_m	M	α, deg	C_L	C_D	C_m
0.70	-6.3	-0.007	0.0068	-0.0122	1.00	-5.8	-0.008	0.0095	-0.0129	1.30	-6.0	-0.010	0.0099	-0.0118	2.22	-5.7	-0.016	0.0092	-0.0090
	-4.3	-.003	.0064	-.0090		-3.8	-.007	.0089	-.0085		-4.0	-.005	.0088	-.0087		-3.6	-.010	.0081	-.0054
	-2.2	-.002	.0060	-.0050		-1.8	-.007	.0086	-.0040		-1.9	-.001	.0084	-.0047		-1.7	-.007	.0073	-.0016
	-.7	0	.0057	-.0018		-.3	-.003	.0073	-.0014		-.5	0	.0082	-.0017		-.2	-.002	.0070	.0005
	-.2	.001	.0057	-.0009		.2	-.001	.0075	-.0007		0	.001	.0082	-.0005		.3	-.003	.0070	.0020
	.3	.002	.0055	.0001		.8	-.001	.0069	.0013		.6	.001	.0081	.0003		.8	-.001	.0070	.0032
	1.7	.003	.0055	.0038		2.2	0	.0070	.0033		2.0	.004	.0073	.0035		2.2	.001	.0069	.0056
	3.8	.004	.0057	.0079		4.3	.003	.0073	.0093		4.1	.007	.0081	.0078		4.3	.005	.0069	.0099
	5.7	.007	.0056	.0117		6.2	.005	.0074	.0133		6.0	.008	.0084	.0115		6.3	.011	.0080	.0133
	7.8	.011	.0072	.0151		8.2	.010	.0089	.0169		8.0	.013	.0093	.0148		8.3	.017	.0093	.0165
	9.8	.015	.0076	.0182		10.2	.015	.0097	.0203		10.1	.019	.0107	.0184		10.3	.028	.0119	.0196
	11.8	.021	.0083	.0218		12.3	.021	.0092	.0241		12.0	.027	.0130	.0221		12.3	.041	.0157	.0221
	13.8	.029	.0102	.0250		14.2	.028	.0120	.0280		14.1	.035	.0162	.0261		14.3	.058	.0213	.0257
	15.8	.036	.0126	.0287		16.3	.036	.0154	.0330		16.1	.047	.0199	.0303		16.4	.075	.0289	.0298
	17.9	.043	.0159	.0335		18.3	.047	.0191	.0369		18.1	.059	.0247	.0347		18.4	.093	.0372	.0335
0.90	-6.0	-.008	.0069	-.0124	1.10	-6.1	-.013	.0132	-.0108	2.22	-5.7	-.016	.0092	-.0090					
	-3.9	-.004	.0062	-.0087		-3.9	-.010	.0122	-.0071		-3.6	-.010	.0081	-.0054					
	-1.9	0	.0060	-.0050		-1.9	-.006	.0109	-.0032		-1.7	-.007	.0073	-.0016					
	-.5	.001	.0057	-.0020		-.5	-.007	.0111	.0005		-.2	-.002	.0070	.0005					
	.1	.001	.0053	-.0003		.1	-.004	.0106	.0005		.3	-.003	.0070	.0020					
	.5	.002	.0054	.0004		.5	-.004	.0103	.0017		.8	-.001	.0070	.0032					
	2.0	.003	.0053	.0038		2.0	0	.0101	.0038		2.2	.001	.0069	.0056					
	4.1	.005	.0054	.0082		4.1	0	.0100	.0095		4.3	.005	.0069	.0099					
	6.0	.009	.0058	.0115		6.0	.003	.0101	.0135		6.3	.011	.0080	.0133					
	8.0	.012	.0065	.0152		8.1	.008	.0107	.0163		8.3	.017	.0093	.0165					
	10.1	.019	.0078	.0182		10.1	.012	.0117	.0198		10.3	.028	.0119	.0196					
	12.1	.024	.0091	.0219		12.0	.021	.0130	.0227		12.3	.041	.0157	.0221					
	14.1	.031	.0117	.0256		14.0	.029	.0147	.0264		14.3	.058	.0213	.0257					
	16.1	.038	.0140	.0296		16.2	.037	.0183	.0309		16.4	.075	.0289	.0298					
	18.1	.048	.0176	.0342		18.1	.047	.0219	.0348		18.4	.093	.0372	.0335					

TABLE II.- AERODYNAMIC CHARACTERISTICS WITH THE WING OFF - Continued

(b) BVC; $\delta = 0^{\circ}$

M	α, deg	C_L	C_D	C_m	M	α, deg	C_L	C_D	C_m	M	α, deg	C_L	C_D	C_m	M	α, deg	C_L	C_D	C_m
0.70	-6.1	-0.053	0.0116	-0.0639	1.00	-5.7	-0.060	0.0156	-0.0722	1.30	-5.8	-0.051	0.0162	-0.0629	2.22	-5.7	-0.037	0.0127	-0.0373
	-4.1	-.032	.0091	-.0416		-3.7	-.039	.0104	-.0458		-3.8	-.033	.0131	-.0429		-3.6	-.025	.0104	-.0230
	-2.1	-.015	.0072	-.0205		-1.7	-.017	.0105	-.0213		-2.0	-.018	.0111	-.0228		-1.7	-.014	.0086	-.0096
	-1.0	-.005	.0068	-.0090		-.1	-.003	.0094	-.0032		-.4	-.003	.0106	-.0064		-.1	-.004	.0083	-.0001
	-.2	-.001	.0066	-.0012		.2	-.003	.0102	.0006		0	0	.0105	-.0025		.4	-.001	.0082	.0032
	.3	.002	.0065	.0033		.8	.004	.0109	.0077		.6	.004	.0106	.0043		.9	.003	.0083	.0065
	1.6	.014	.0069	.0161		2.2	.017	.0102	.0240		2.1	.018	.0115	.0192		2.3	.010	.0086	.0155
	3.7	.031	.0084	.0377		4.2	.037	.0117	.0483		4.1	.037	.0129	.0402		4.3	.022	.0097	.0291
	5.7	.050	.0104	.0597		6.2	.058	.0158	.0740		6.0	.054	.0154	.0614		6.3	.035	.0124	.0425
	7.6	.068	.0145	.0814		8.1	.079	.0188	.0962		7.9	.069	.0199	.0815		8.1	.048	.0155	.0551
	9.6	.085	.0197	.0987		10.1	.097	.0247	.1187		9.8	.085	.0251	.1001		10.2	.059	.0505	.0686
	11.7	.091	.0247	.1067		12.0	.113	.0310	.1388		11.9	.102	.0322	.1185		12.1	.083	.0279	.0801
	13.5	.094	.0285	.1111		14.0	.129	.0380	.1593		13.8	.117	.0397	.1341		14.1	.104	.0369	.0919
	15.6	.103	.0347	.1191		15.9	.145	.0475	.1767		15.8	.132	.0483	.1479		16.0	.126	.0471	.1040
	17.4	.111	.0399	.1287		17.9	.154	.0551	.1896		17.8	.149	.0585	.1626		18.0	.150	.0602	.1175
0.90	-5.8	-.057	.0121	-.0716	1.10	-5.9	-.059	.0194	-.0676	1.70	-6.0	-.044	.0153	-.0501					
	-3.8	-.035	.0087	-.0449		-3.8	-.040	.0161	-.0428		-4.1	-.029	.0126	-.0338					
	-1.9	-.015	.0077	-.0214		-1.9	-.020	.0139	-.0210		-2.1	-.016	.0107	-.0167					
	-.4	-.002	.0069	-.0047		-.4	-.004	.0127	-.0036		-.5	-.005	.0099	-.0029					
	0	.001	.0072	-.0010		0	-.003	.0136	-.0001		-.2	-.001	.0099	-.0003					
	.7	.007	.0070	.0055		.6	.002	.0134	.0066		.4	.002	.0098	.0044					
	2.0	.019	.0073	.0199		2.1	.016	.0135	.0231		1.9	.013	.0103	.0168					
	3.7	.036	.0085	.0413		4.0	.038	.0157	.0466		3.9	.028	.0118	.0340					
	6.1	.062	.0123	.0741		6.0	.056	.0187	.0688		5.7	.041	.0143	.0502					
	7.9	.082	.0170	.0956		7.9	.073	.0229	.0888		7.7	.056	.0181	.0672					
	9.8	.099	.0227	.1172		9.9	.087	.0284	.1101		9.7	.072	.0230	.0835					
	11.9	.117	.0301	.1382		11.8	.103	.0346	.1297		11.7	.087	.0293	.0991					
	13.9	.115	.0343	.1328		13.8	.119	.0423	.1490		13.6	.104	.0367	.1130					
	15.8	.123	.0400	.1401		15.8	.136	.0519	.1659		15.6	.123	.0464	.1258					
	17.7	.132	.0470	.1479		17.7	.146	.0599	.1802		17.5	.145	.0580	.1369					

[redacted]

TABLE II.- AERODYNAMIC CHARACTERISTICS WITH THE WING OFF - Continued

(c) BVC; $\delta = 4.7^\circ$

M	α, deg	C_L	C_D	C_m
0.70	-6.0	-0.027	0.0089	-0.0277
	-2.2	.010	.0071	.0080
	-.7	.022	.0076	.0225
	-.3	.025	.0079	.0278
	1.9	.047	.0101	.0513
	5.7	.079	.0186	.0880
	9.6	.093	.0264	.0996
	13.5	.108	.0360	.1123
	17.6	.134	.0519	.1323
0.90	-5.8	-.025	.0085	-.0289
	-1.9	.012	.0076	.0097
	0	.032	.0085	.0339
	2.1	.056	.0115	.0616
	6.1	.099	.0226	.1078
	9.9	.109	.0313	.1189
	13.8	.128	.0430	.1363
	17.7	.152	.0594	.1565
1.00	-5.6	-0.025	0.0105	-0.0273
	-1.7	.016	.0088	.0134
	-.2	.033	.0132	.0327
	.3	.040	.0108	.0384
	2.2	.058	.0159	.0630
	6.2	.100	.0232	.1052
	10.1	.135	.0381	.1478
	14.0	.160	.0526	.1748
	17.9	.178	.0705	.1881
1.10	-5.8	-.027	.0152	-.0266
	-2.1	.013	.0138	.0107
	.1	.036	.0153	.0359
	2.1	.057	.0186	.0589
	6.0	.091	.0275	.0984
	9.8	.122	.0407	.1376
	13.8	.145	.0559	.1673
	17.7	.163	.0733	.1797
1.30	-5.9	-0.026	0.0128	-0.0288
	-2.0	.012	.0112	.0105
	.1	.031	.0127	.0315
	2.1	.049	.0151	.0521
	6.1	.083	.0242	.0925
	9.9	.112	.0366	.1262
	13.8	.141	.0530	.1566
	17.8	.168	.0740	.1807
1.70	-6.1	-.026	.0126	-.0219
	-2.1	.010	.0104	.0092
	-.2	.022	.0119	.0261
	1.9	.038	.0140	.0430
	5.8	.066	.0214	.0759
	9.6	.094	.0325	.1057
	13.7	.125	.0493	.1345
	17.4	.162	.0713	.1536
2.22	-5.7	-0.023	0.0109	-0.0148
	-1.7	.004	.0086	.0083
	.3	.018	.0098	.0217
	2.4	.031	.0113	.0356
	6.0	.054	.0176	.0618
	10.2	.083	.0292	.0891
	14.3	.124	.0480	.1118
	17.9	.166	.0718	.1321

[redacted]

TABLE II.- AERODYNAMIC CHARACTERISTICS WITH THE WING OFF - Continued

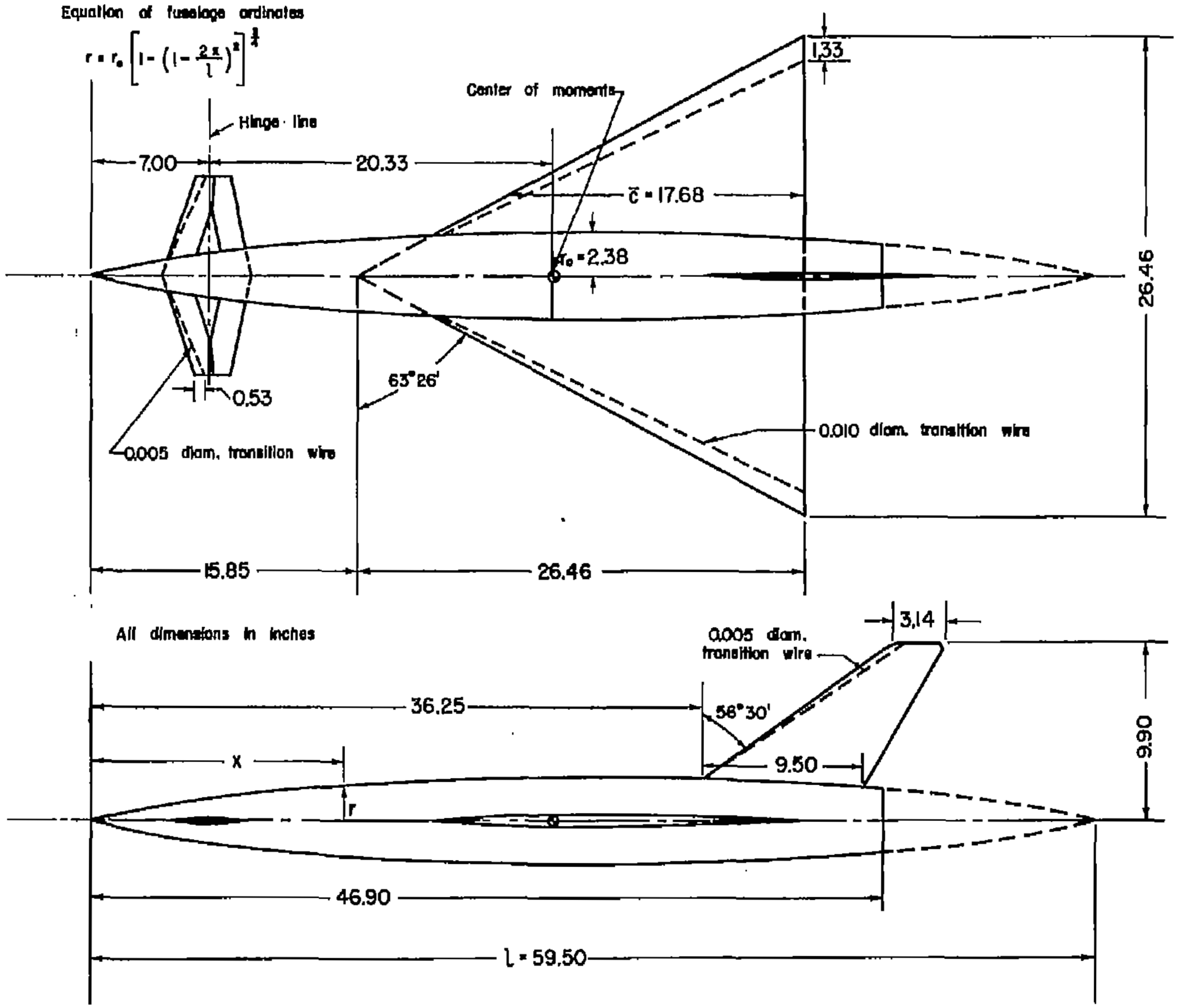
(d) BVC; $\delta = 10.1^\circ$

M	α, deg	C_L	C_D	C_m
0.70	-6.1	0.001	0.0076	0.0025
	-2.2	.038	.0108	.0433
	-.2	.054	.0143	.0634
	1.8	.067	.0182	.0800
	5.7	.078	.0250	.0897
	9.6	.094	.0330	.1031
	13.5	.112	.0444	.1226
	17.5	.134	.0605	.1431
0.90	-5.8	.006	.0082	.0056
	-1.9	.049	.0124	.0564
	.1	.068	.0166	.0798
	2.1	.084	.0216	.0980
	6.0	.095	.0292	.1062
	9.9	.113	.0396	.1267
	13.8	.132	.0523	.1453
	17.7	.151	.0685	.1634
1.00	-5.7	0.010	0.0105	0.0080
	-1.7	.049	.0143	.0579
	.2	.068	.0188	.0792
	2.2	.086	.0238	.1000
	6.1	.123	.0369	.1391
	10.1	.135	.0479	.1593
	14.1	.153	.0639	.1823
	17.9	.170	.0801	.1999
1.10	-5.9	.005	.0152	.0080
	-1.9	.044	.0193	.0537
	.1	.061	.0229	.0742
	2.0	.077	.0277	.0937
	5.9	.110	.0402	.1301
	9.9	.123	.0517	.1513
	13.8	.141	.0665	.1740
	17.7	.161	.0854	.1905
1.30	-5.9	0.004	0.0127	0.0068
	-2.0	.041	.0159	.0463
	.1	.056	.0195	.0660
	2.1	.073	.0241	.0846
	6.0	.102	.0350	.1176
	9.9	.127	.0498	.1501
	13.8	.148	.0657	.1742
	17.7	.163	.0832	.1860
1.70	-6.0	0	.0125	.0065
	-2.1	.030	.0149	.0386
	-.2	.044	.0176	.0546
	1.9	.058	.0216	.0705
	5.8	.084	.0315	.0997
	9.7	.108	.0441	.1286
	13.6	.133	.0617	.1537
	17.6	.163	.0839	.1716
2.22	-5.5	-0.002	0.0105	0.0067
	-1.7	.023	.0121	.0314
	.3	.034	.0143	.0443
	2.3	.047	.0174	.0581
	6.2	.071	.0268	.0855
	10.1	.095	.0396	.1107
	14.0	.127	.0573	.1297
	18.0	.167	.0831	.1483

TABLE II.- AERODYNAMIC CHARACTERISTICS WITH THE WING OFF - Concluded

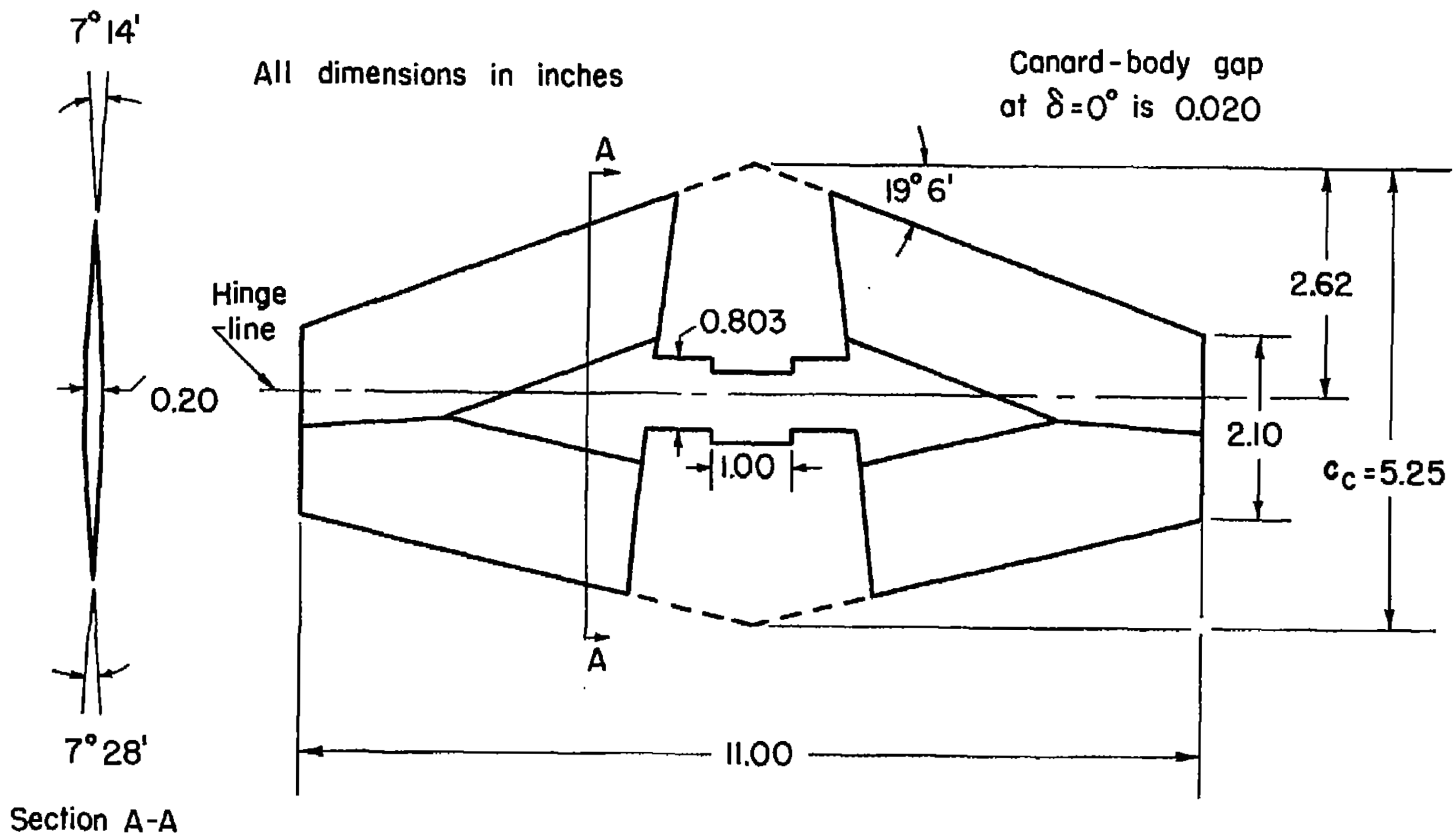
(e) BVC; $\delta = 20.0^{\circ}$

M	α, deg	C_L	C_D	C_m	M	α, deg	C_L	C_D	C_m	M	α, deg	C_L	C_D	C_m	M	α, deg	C_L	C_D	C_m
0.70	-6.1	0.052	0.0189	0.0562	1.00	-5.5	0.068	0.0275	0.0799	1.30	-5.8	0.055	0.0247	0.0630	2.22	-5.5	0.032	0.0200	0.0443
	-2.2	.062	.0231	.0677		-1.7	.094	.0361	.1172		-1.9	.081	.0339	.0944		-1.7	.056	.0259	.0682
	-.1	.066	.0266	.0741		.3	.101	.0405	.1242		.1	.093	.0394	.1088		.4	.066	.0305	.0808
	1.8	.070	.0294	.0810		2.2	.107	.0437	.1322		2.0	.105	.0452	.1221		2.3	.077	.0356	.0914
	5.7	.083	.0367	.0977		6.2	.131	.0575	.1538		6.0	.122	.0572	.1421		6.0	.093	.0468	.1127
	9.7	.105	.0471	.1118		10.1	.148	.0714	.1744		9.9	.141	.0729	.1644		10.2	.112	.0618	.1346
	13.5	.124	.0611	.1313		13.9	.149	.0828	.1875		13.8	.151	.0870	.1805		14.1	.138	.0807	.1516
						17.9	.160	.0985	.2033		17.6	.155	.1016	.1937		18.0	.169	.1044	.1654
0.90	-5.8	.055	.0204	.0609	1.10	-5.8	.065	.0291	.0724	1.70	-6.0	.042	.0231	.0520					
	-1.9	.073	.0278	.0828		-1.9	.089	.0392	.1074		-2.1	.067	.0303	.0792					
	.1	.080	.0313	.0920		.1	.093	.0431	.1137		-.2	.078	.0348	.0922					
	2.0	.087	.0360	.1027		2.1	.102	.0481	.1225		1.9	.088	.0406	.1050					
	6.0	.100	.0441	.1161		6.0	.120	.0604	.1446		5.6	.108	.0529	.1286					
	10.0	.121	.0565	.1339		9.9	.139	.0750	.1655		9.7	.128	.0689	.1524					
	13.8	.139	.0698	.1498		13.8	.144	.0888	.1763		13.7	.142	.0849	.1676					
						17.7	.150	.1004	.1915		17.6	.161	.1051	.1824					



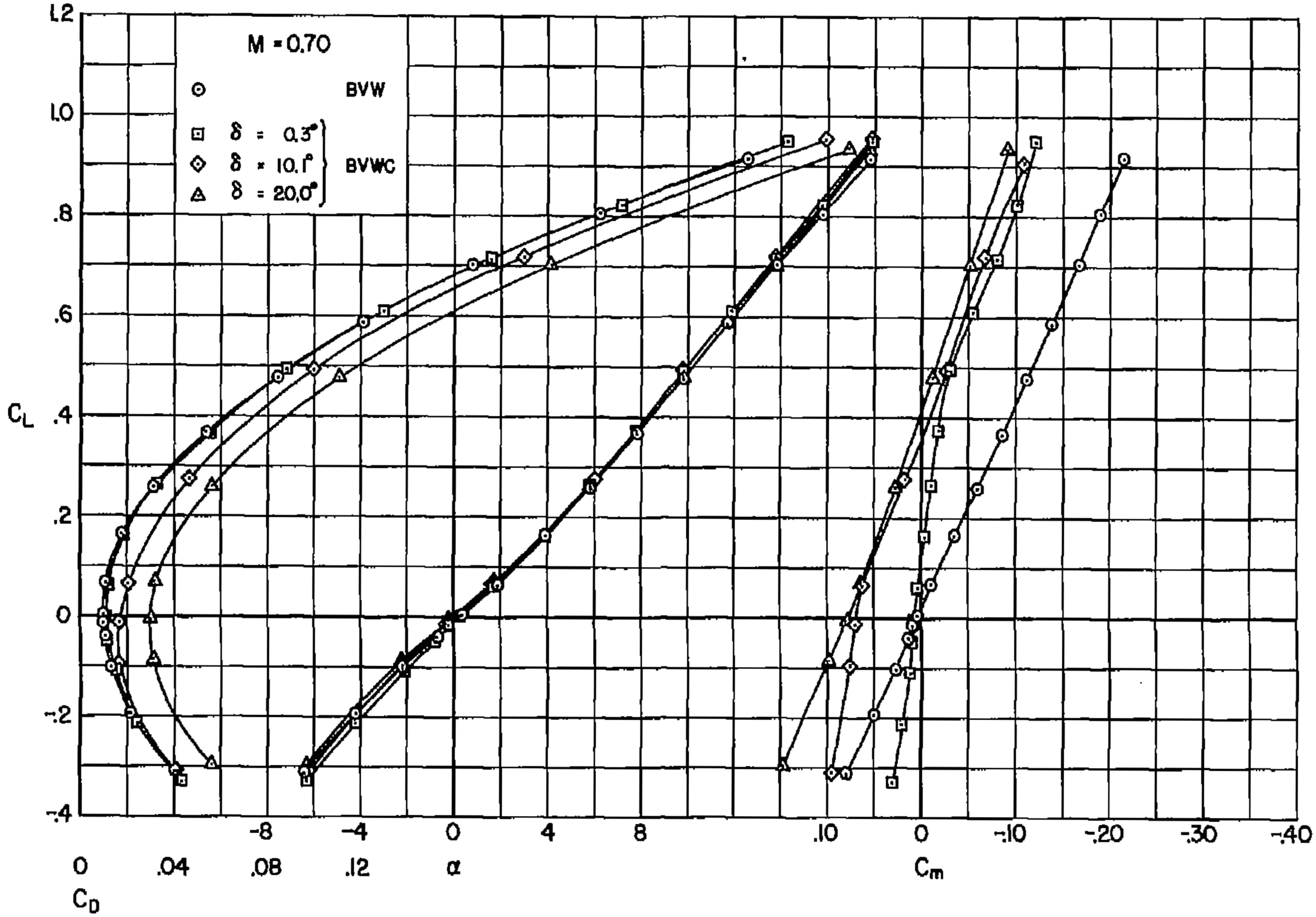
(a) Dimensional sketch of complete model.

Figure 1.- Model details and dimensions.



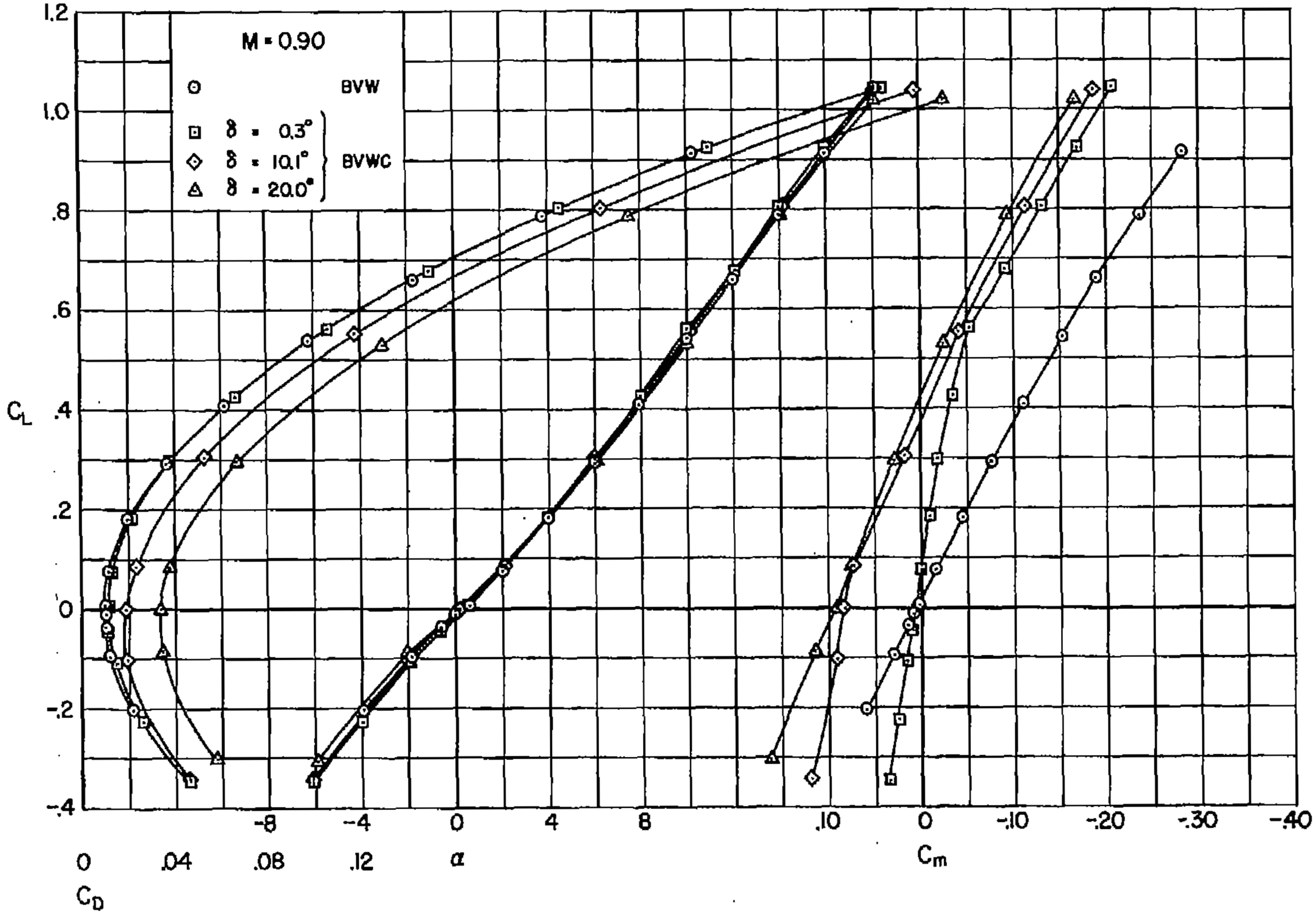
(b) Details of canard surface.

Figure 1.- Concluded.



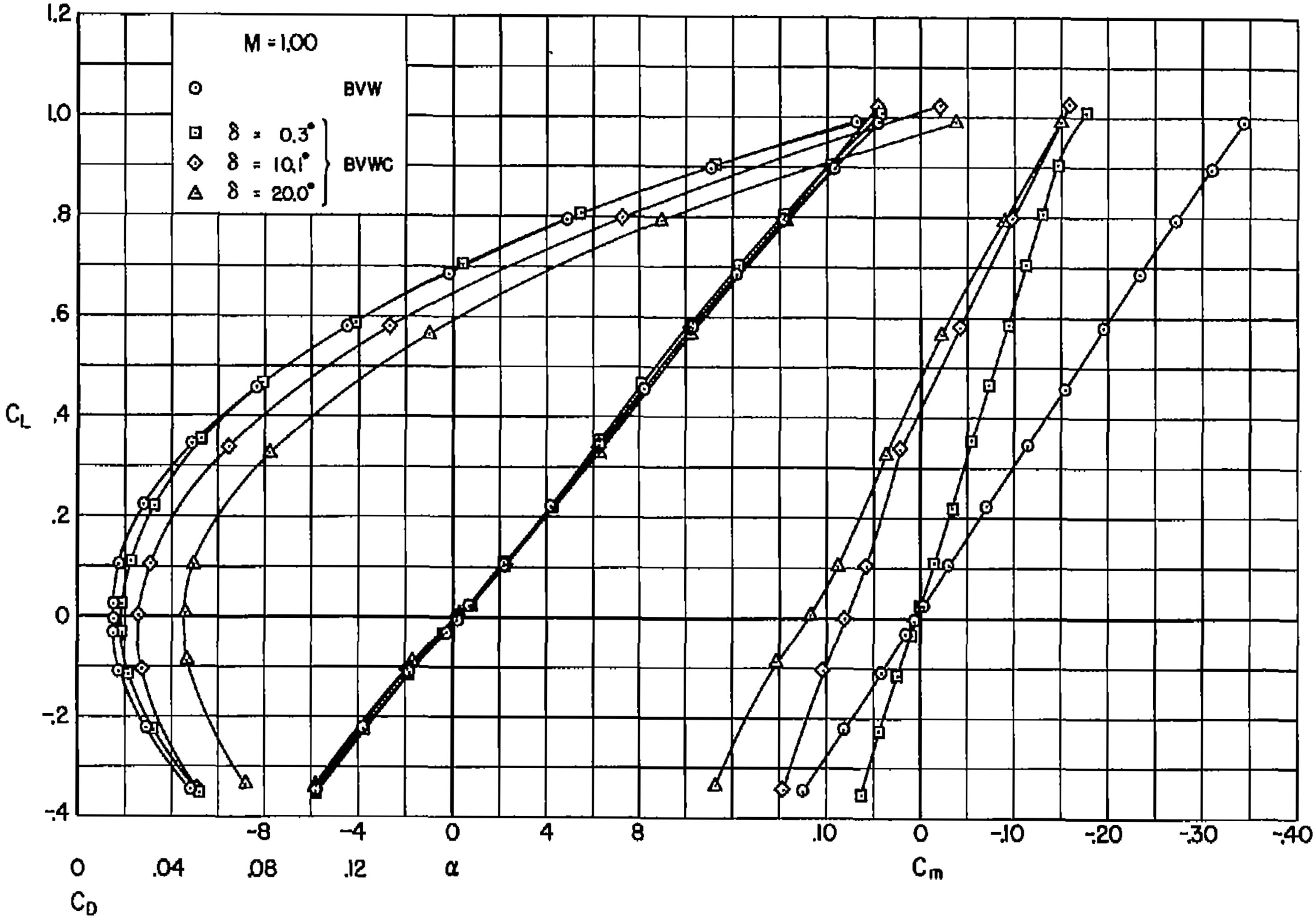
(a) M = 0.70

Figure 2.- Lift, drag, and pitching-moment characteristics for the canard on and deflected and the canard off.



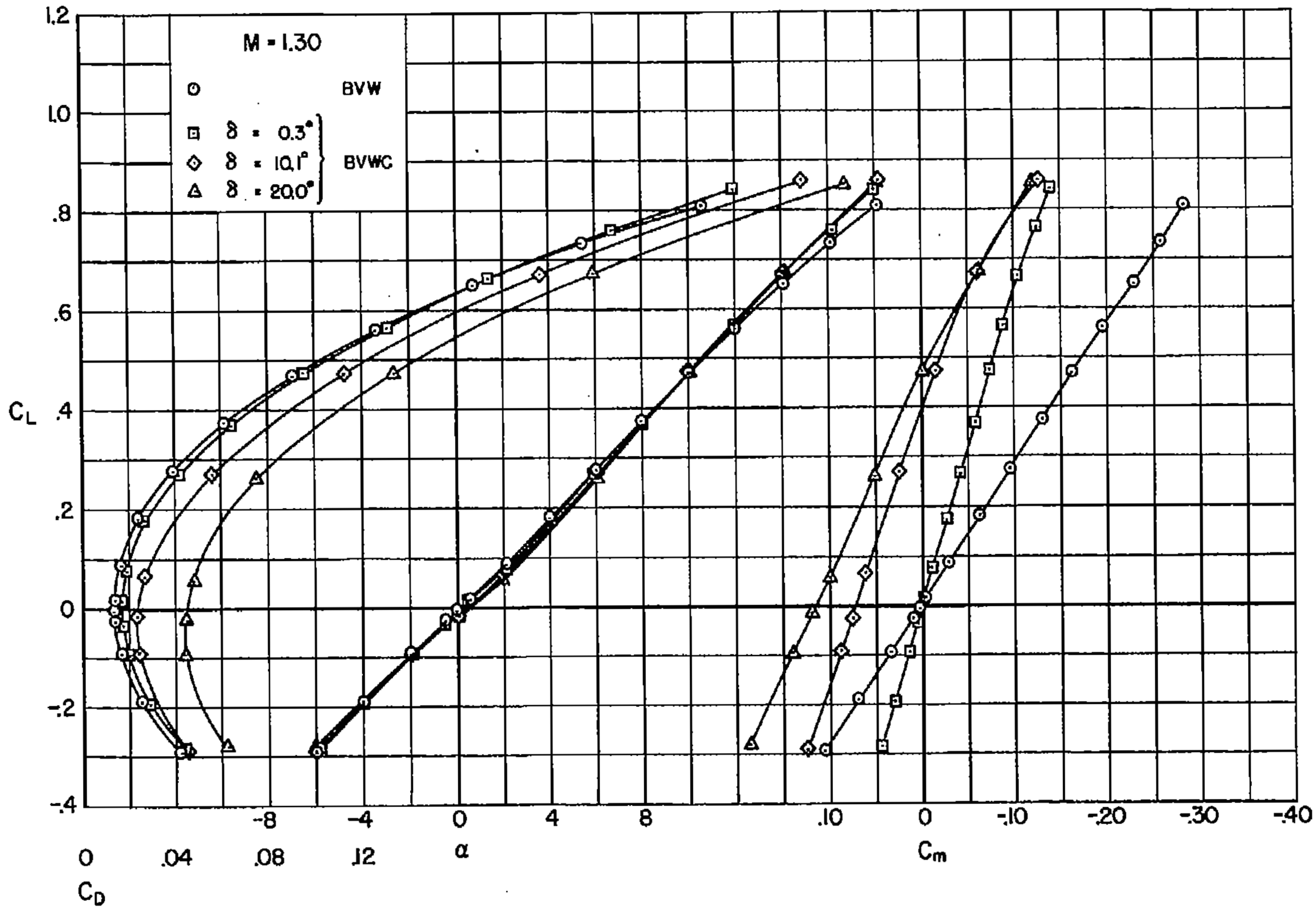
(b) M = 0.90

Figure 2.- Continued.



(c) M = 1.00

Figure 2.- Continued.



(d) M = 1.30

Figure 2.- Continued.

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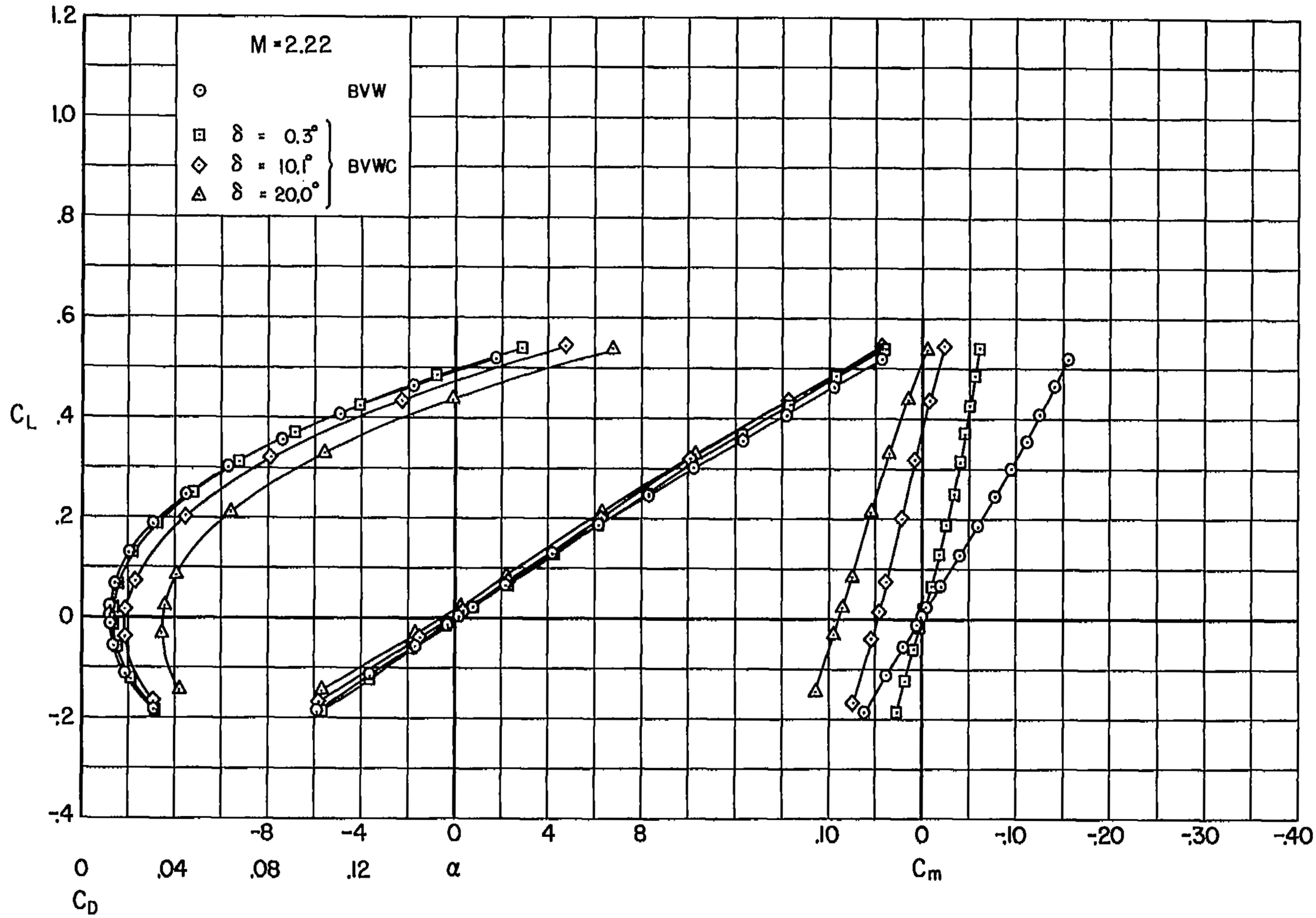

(e) M = 2.22

Figure 2.- Concluded.

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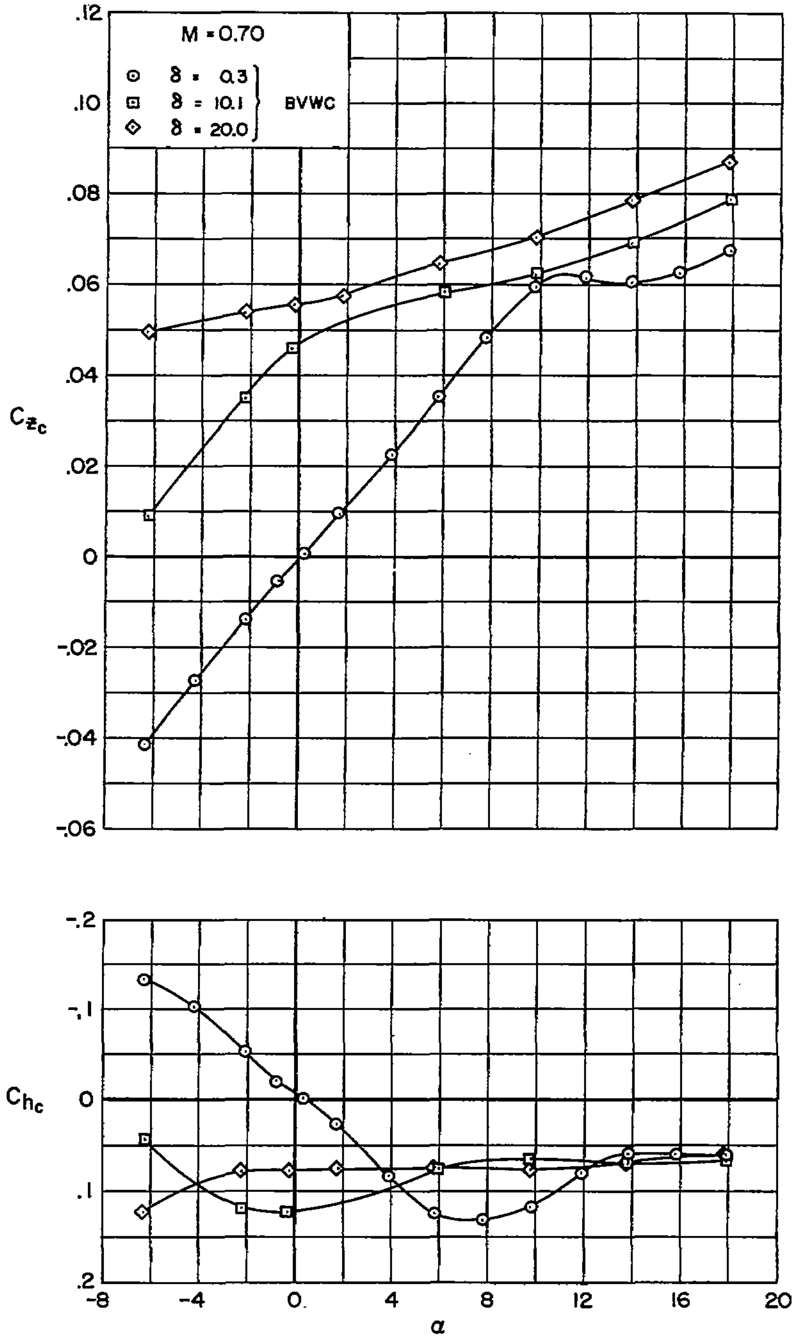
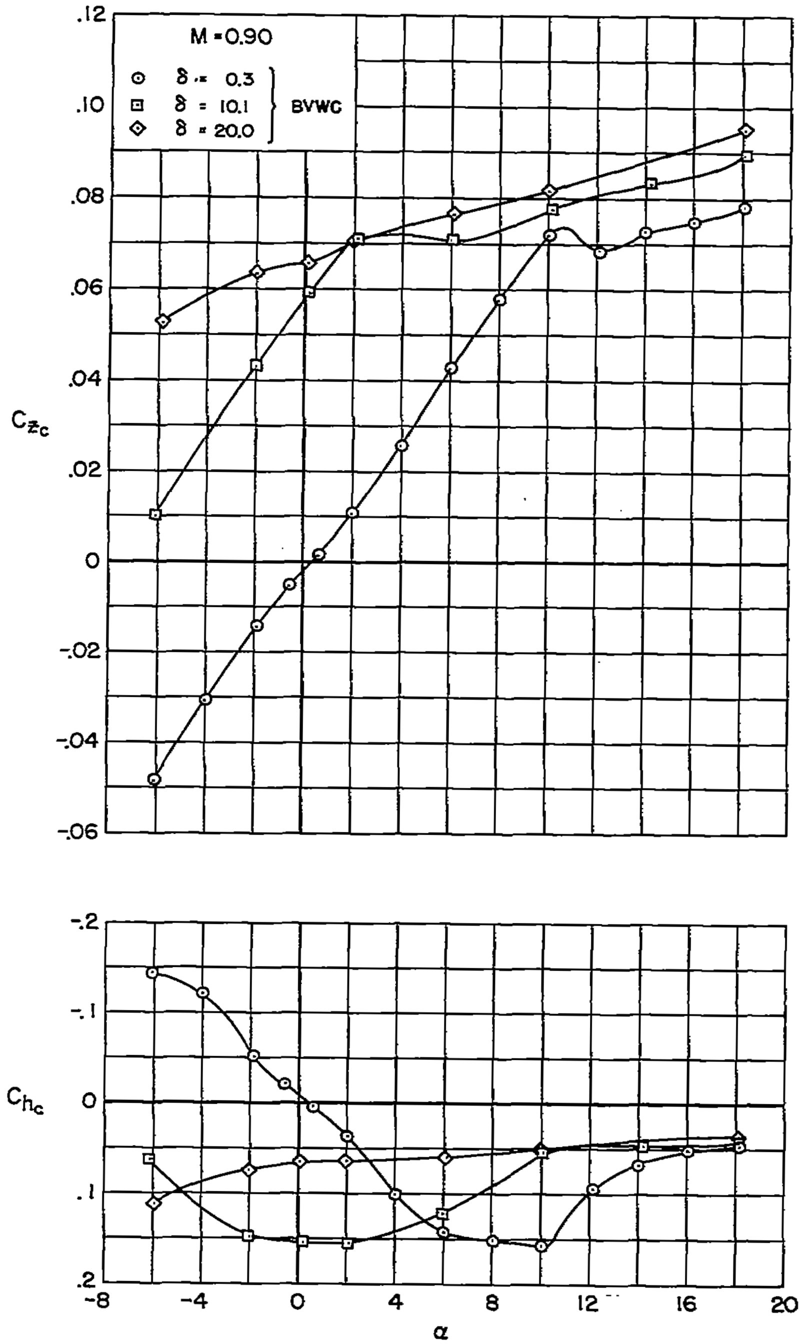


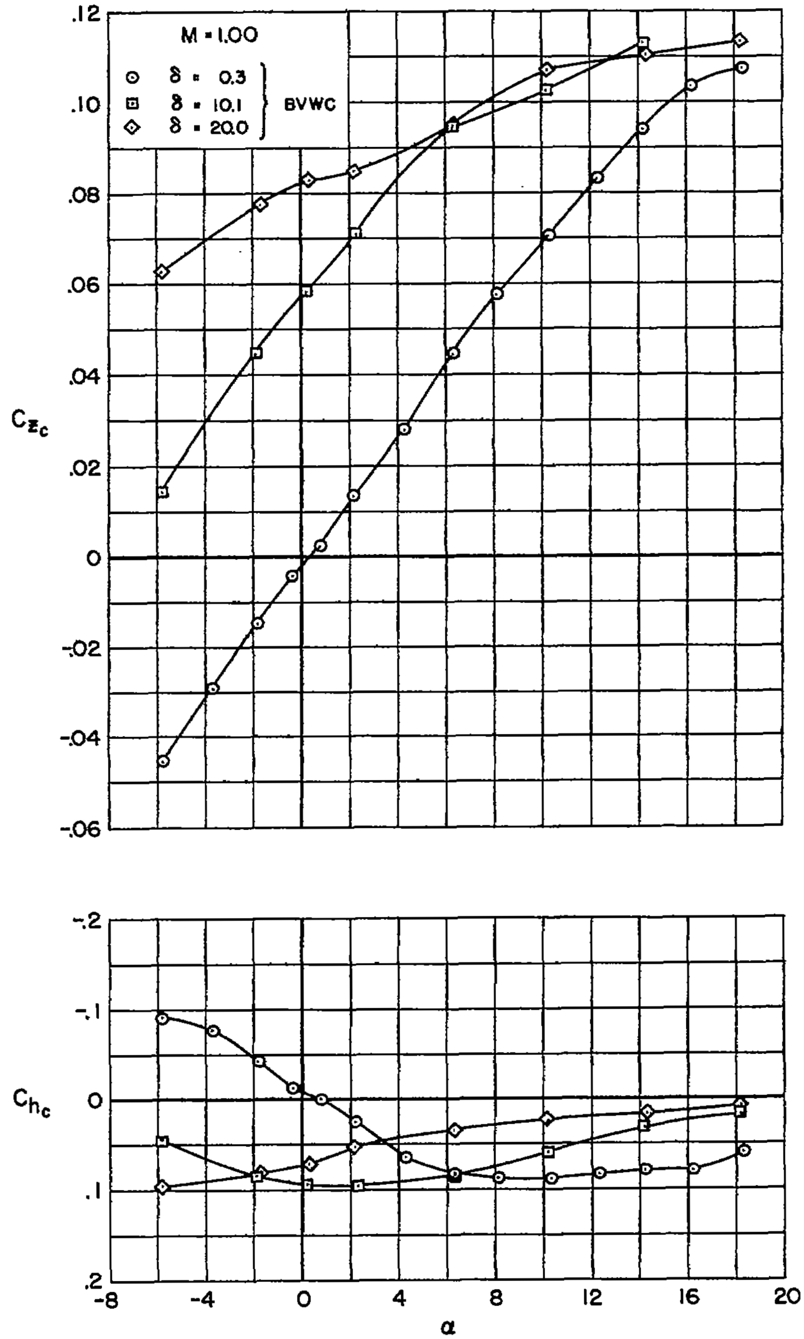
(a) M = 0.70

Figure 3.- Variation of canard normal-force and hinge-moment coefficients as a function of angle of attack at constant canard deflection angles.



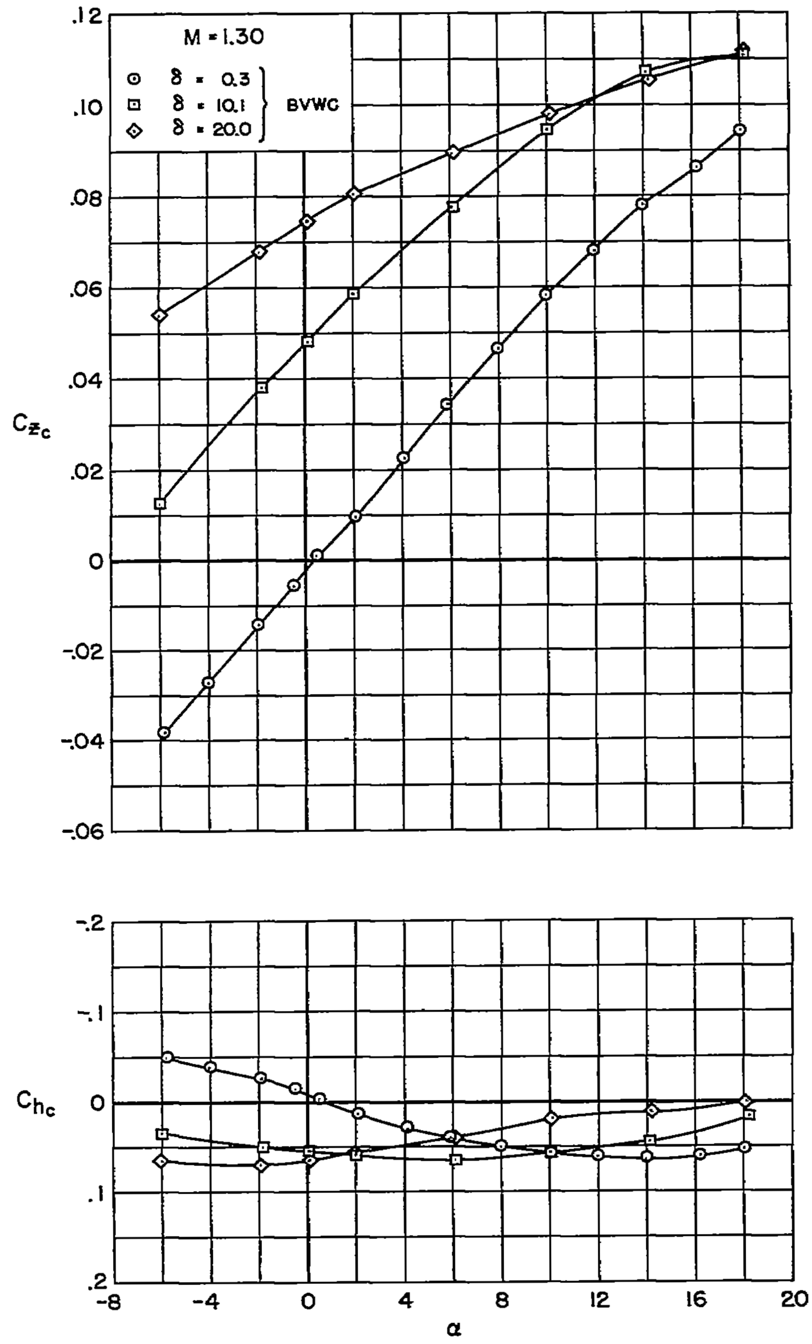
(b) M = 0.90

Figure 3.- Continued.



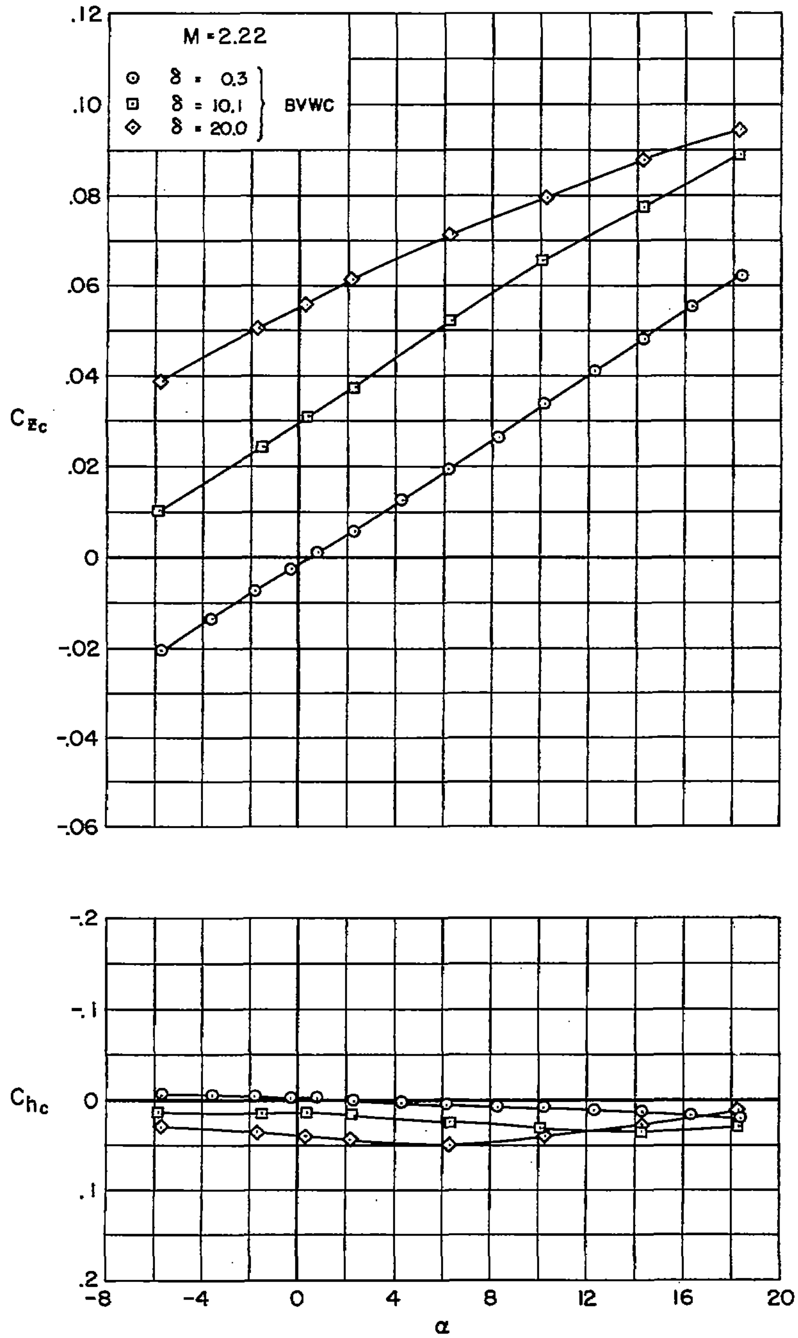
(c) M = 1.00

Figure 3.- Continued.



(d) M = 1.30

Figure 3.- Continued.



(e) M = 2.22

Figure 3.- Concluded.

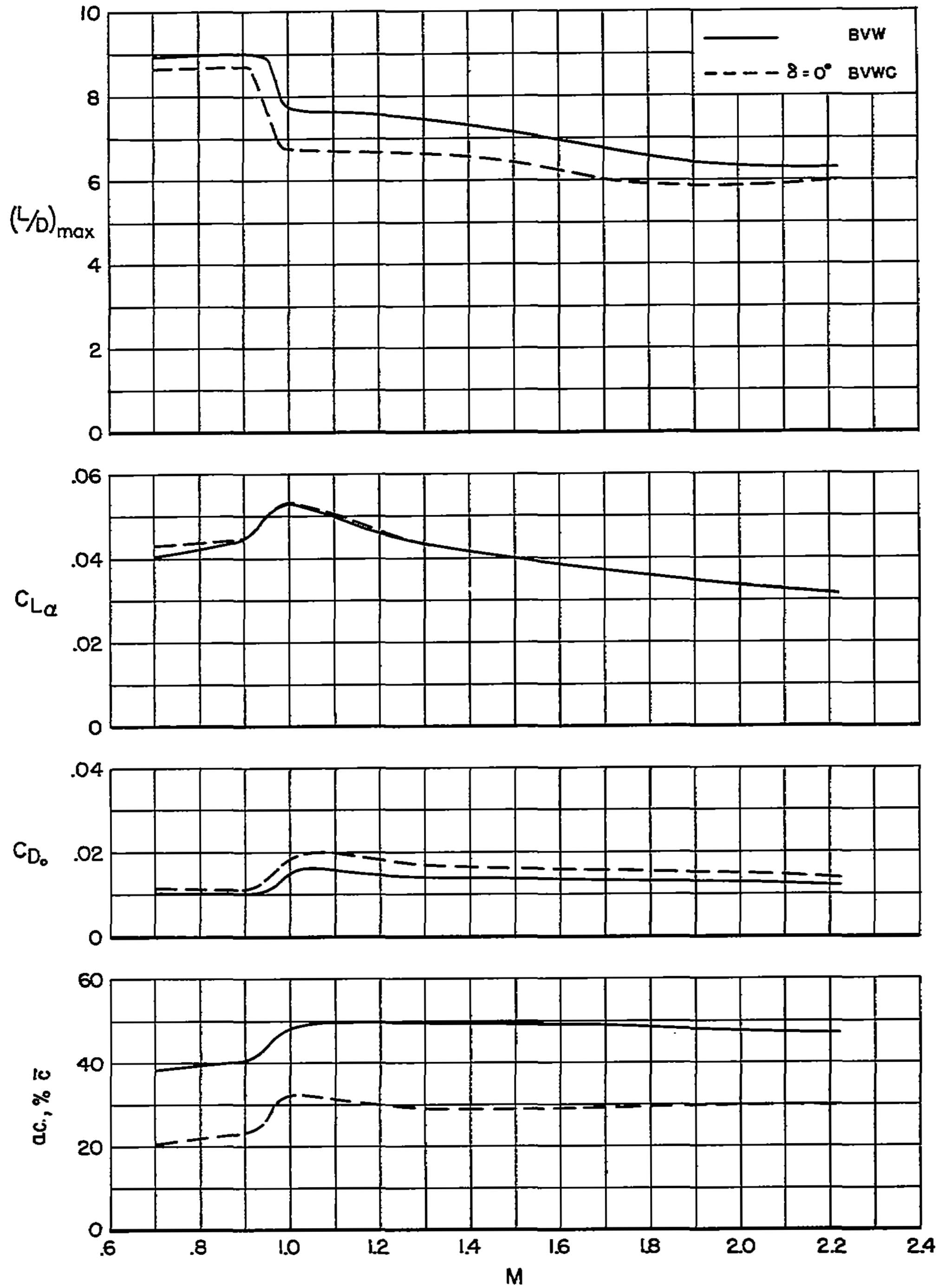


Figure 4.- Variation of maximum lift-drag ratios, lift-curve slopes, minimum drag coefficients, and aerodynamic centers as a function of Mach number for the canard on and off.

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